PRESS-IN EXCITER RING ASSEMBLY

FIELD OF THE INVENTION

[0001] The present invention relates generally to speed sensing devices and specifically to a device to measure the speed of a motor vehicle axle.

BACKGROUND OF THE INVENTION

[0002] The advent of anti-lock braking systems and traction control systems have created a need for accurate speed measurement of individual wheels of a vehicle. Accordingly, there has been an increase in motor vehicles equipped with speed sensing devices to measure axle rotation which, in turn, enables measurement of wheel speed.

[0003] Typically, a ferrous or magnetic exciter ring is installed to rotate with an axle. A sensor, fixed with respect to axle rotation, is placed in the vicinity of the teeth of the exciter ring. When an exciter ring is rotated near a variable reluctance sensor, the teeth on the exciter ring pass through the magnetic lines of flux generated by the magnet in the sensor. As the teeth are passing through the magnetic lines of flux, a voltage is generated in the coil within the sensor. The magnitude of the voltage is related to the speed and size of the exciter ring teeth in addition to design parameters inside the sensor, and inversely related to the distance between the sensor and the exciter ring teeth. The exciter ring assembly will also work similarly with an active (Hall Effect) sensor. The sensor is coupled to a control system which calculates the angular speed of the axle. The best sensor design selection is dependent upon the needs of the controller system. Calculation is carried out with inputs of the number of teeth sensed per unit of time and

the known number of teeth of the exciter ring. During acceleration or deceleration, the instantaneous speed of the axle is not directly measurable by these speed sensing devices due to the finite number of teeth on the exciter ring. Thus, the accuracy of these devices is limited by the number of teeth of the exciter ring. A larger diameter exciter ring that provides more teeth can be used to obtain a more accurate speed measurement.

[0004] A variety of speed sensing devices have been used in the art. An example of a known speed sensing device is shown in U. S. Patent 5,067,350 to Grillo et al. which discloses an annular exciter ring. Another example is disclosed in U. S. Patent 5,967,669 to Ouchi. Here, a roller bearing unit includes an integral exciter ring.

[0005] It is known within the art to mount an exciter ring or target in the differential area of a driven axle. This location can usually accommodate a larger wheel since the differential housing within an axle assembly is typically of a larger diameter than the axle tube. One limitation to a speed sensing device located near the differential is the inaccuracy of the speed measurement associated with the elastic twisting of an axle under a torque loading or torque windup. While an axle is twisting, the actual wheel speed is not measured.

[0006] Alternatively, it is known to provide a speed sensing device that is integral with the wheel bearing assembly of an axle. This location reduces the inaccuracy due to torque windup, and increase complexity and mass. Additionally, the bearing assembly will have a higher cost and a different seal assembly may be required. While the above speed sensing devices may perform adequately for their intended purposes, a need exists for an improved exciter ring assembly that is less complex, provides for easier installation, and results in a more accurate measurement of actual wheel speed.

SUMMARY OF THE INVENTION

[0007] In view of the above, the present invention is directed to an exciter ring assembly that can be interference or press fit into an axle tube. An exciter ring is provided with teeth and is affixed to an axle. A sensor is fixed to the axle tube and located close to the teeth of the exciter ring. As the axle rotates, the sensor detects the movement of the exciter ring teeth. The sensitivity of the assembly is inversely related to the distance between the sensor and the teeth (typically a few millimeters or less). The exciter ring rotates in relation to an outer member that encompasses an integral lip of the ring. The outer member supplies the outside diameter for a press fit with an inside diameter of the axle tube. The axle tube can be provided with a bore inboard of the wheel bearing bore to accommodate this press fit. The outer member is constructed of stamped metal or similar construction capable of withstanding the press fit. Flutes are provided in the circumference of the outer member to promote oil flow past the exciter ring assembly and lubricate the wheel bearing. A spacer is located within the outer member and adjacent to the lip of the exciter ring to provide the correct spacing for the final assembly. The spacer helps to prevent noise in the assembly Additionally, the spacer is provided with cut-outs that enable oil flow past the exciter ring assembly. The press fit installation of the exciter ring assembly simplifies assembly since no further alignment or positioning of the exciter ring is necessary to ensure that the sensor, when installed, is within the required proximity to the teeth of the exciter ring.

[0008] The exciter ring assembly is press fit into the axle tube between the bearings that support the axle. The exciter ring assembly can be installed into the axle

tube during manufacture of the axle assembly prior to installation of the wheel bearing. This location of the exciter ring assembly, near the wheel bearing, will ease axle alignment with the exciter ring bore during axle installation. Also the location reduces speed sensing inaccuracies due to torque windup. The diameter of the exciter ring can be larger than typical wheel bearing speed sensing rings and thus provide for more accurate speed measurement.

[0009] A further benefit to locating the exciter ring near the wheel bearing is derived from the lower amount of axle deflection near the bearings than at a location further from the bearings. Lower axle deflection reduces the gap variation distance between the sensor and teeth which, in turn, provides improved sensitivity. Lower axle deflection also reduces the maximum distance between the sensor and teeth which also provides improved sensitivity.

[0010] Further areas of applicability of the present invention will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating the preferred embodiment of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The present invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

[0012] FIG. 1 is a schematic representation of an exemplary vehicle having the present invention incorporated therein;

[0013] FIG. 2 is a sectional view of the axle assembly taken along line 2-2 of FIG. 1 incorporating the present invention;

[0014] FIG. 3 is a sectional view of the exciter ring assembly taken along line 3-3 of FIG. 2 showing the ring teeth and elastomer insert flutes;

[0015] FIG. 4 is a sectional view of the exciter ring assembly along the axis of the axle showing the exciter ring lip;

[0016] FIG. 5 is a sectional view of the outer member of the exciter ring assembly taken perpendicular to the axis of the assembly showing recesses for oil flow;

[0017] FIG. 6 is an alternate embodiment of the outer member of the exciter ring assembly showing cutouts for oil flow;

[0018] FIG. 7 a view of the spacer utilized within the exciter ring assembly taken perpendicular to the axis of the assembly; and

[0019] FIG. 8 an alternate embodiment of the spacer utilized within the exciter ring assembly.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0020] The following description of the preferred embodiment(s) is merely exemplary in nature and is in no way intended to limit the invention, its application, or uses.

[0021] In general, the present invention is directed to a speed sensing device which is operably installed within an axle tube. Referring to FIGS. 1 and 2, a four wheel

drive vehicle 10 is schematically shown with axle assembly 12. Axle assembly 12 interconnects wheels 14. A controller 16 receives data from sensors 18. This data relates to the rotational parameters of axle 20. Sensors 18 are connected to axle assembly 12. Controller 16 is adapted to supply data to anti-lock braking systems, traction control systems, adaptive four-wheel drive systems or the like. Axle 20 is rotatably supported in axle tube 22 by differential bearing 24 and wheel bearing 26. Sensor 18 is mounted to axle tube 22 in close proximity to exciter ring 28. In the embodiment shown, exciter ring 28 is provided with an elastomer insert 30 that is sized for an interference fit with axle 20. Thus provided, exciter ring 28 is coupled to rotate with axle 20.

[0022] With continued reference to FIG. 2, exciter ring assembly 32 includes exciter ring 28 which is provided with lip 34. Exciter ring assembly 32 also includes outer member 36. The circumference of lip 34 fits within outer member 36 and is rotatable therewith. Outer member 36 is press fit into exciter ring axle bore 38 of axle tube 22. Wheel bearing 26 is fitted into wheel bearing bore 40 of axle tube 22.

[0023] With reference to FIG. 3, exciter ring assembly 32 is shown in cross section perpendicular to the axis of axle 20. Exciter ring 28 has an inside surface 42 that is attached to elastomer insert 30. Preferably, the insert is of an elastomeric material. Elastomer insert 30 has channels 44 that are provided to enable oil flow between elastomer insert 30 and axle 20. An interior surface 46 of elastomer insert 30 is interference fit with axle 20 to ensure that exciter ring 28 rotates with axle 20. In the embodiment shown, oil channels 44 are formed in interior surface 46 of elastomer insert 30 to form interior surface 48 of elastomer insert 30.

[0024] With continued reference to FIG. 3, exciter ring 28 has teeth 50. Sensor 18, also shown in FIG. 2, detects the presence or absence of teeth 50 as exciter ring 28 rotates around the axis of axle 20. In the preferred embodiment, fifty-five teeth 50 are equally spaced around the circumference of exciter ring 28. As is known, sensor 18 can be operably connected to a controller 16 to calculate the rotational parameters of exciter ring 28. Rotational parameters include wheel speed and acceleration. These rotational parameters can be used as input to an anti-locking brake system, traction control system, torque modulating four-wheel drive system or other systems that require vehicle or wheel speed. An exemplary control system is described in U. S. Patent 5,332,060, the specification and drawings therein are expressly incorporated by reference.

[0025] When the exciter ring 28 is rotated near the variable reluctance sensor 18, the teeth 50 on the exciter ring 28 pass through magnetic lines of flux generated by a magnet in the sensor 18. As the teeth 50 are passed through the magnetic lines of flux, a voltage is generated in a coil within the sensor 18. The magnitude of the voltage is related to the speed and size of the exciter ring teeth 50 in addition to design parameters within the sensor 18. A larger diameter exciter ring provides more teeth which in turn provides increased accuracy in the measurement of rotational parameters. In addition, a larger diameter exciter ring enables larger teeth and faster peripheral speed both of which improve sensitivity of the system and enable increased manufacturing tolerances and reduced cost. The magnitude of the voltage is inversely related to the distance between the sensor 18 and the exciter ring teeth 50. The lower the deflection of the shaft, the less gap variation and the less the maximum gap, both of which provide for improved

sensitivity. The exciter ring assembly will also work similarly with an active (Hall Effect) sensor.

[0026] With reference to FIG. 4, exciter ring assembly 32 is shown in cross section along the axis of axle 20. Exciter ring 28 is shown with lip 34 within outer member 36. Spacer 52 is shown adjacent to a first annular surface 54 of lip 34. Outer member 36 is shown to enclose lip 34 of exciter ring 28 and spacer 52. Outer member 36 enables rotation of exciter ring 28 about the axis of axle 20. Exciter ring 28 is limited in its axial movement with respect to sensor 18 during installation due to the interference between outer member 36 and first and second radially projecting annular surfaces 54, 56 of lip 34.

[0027] FIG. 5 shows the preferred embodiment of outer member 36 with circumferential recesses 58 formed along the axial length of outer member 34. The recesses 58 enable oil flow past the exciter ring assembly 30. FIG. 6 shows an alternate embodiment of outer member 36 with circumferential cutouts 60 to permit oil flow past the exciter ring assembly 32.

[0028] FIG. 7 shows the preferred embodiment of spacer 52. Outside apertures 62 enable oil flow through the exciter ring assembly 30. FIG. 8 shows an alternate embodiment of spacer 52. Here, inside apertures 62 enable oil flow through exciter ring assembly 32. Alternatively, a coating may be added to the lip to act as a spacer. Here grooves may be present to enhance oil flow. Additionally, the coating, like the spacer, acts to reduce noise.

[0029] The description of the invention is merely exemplary in nature and, thus, variations that do not depart from the gist of the invention are intended to be within

the scope of the invention. Such variations are not to be regarded as a departure from the spirit and scope of the invention.